Table 10. Basis for Selection of Ecological Process Ecosystem Elements (continued).

Ecological Process	Basis for Selection as an Ecosystem Element
Bay-Delta Hydrodynamics	Bay-Delta hydrodynamics refers to the direction and velocity of flows in the Bay-Delta channels on a temporal, tidal, and seasonal basis for a given hydrologic condition. The direction and velocity of flows and their distribution in time and location help define the extent to which the Bay-Delta can support important ecological functions such as sustaining a productive food web, providing spawning, rearing, and feeding habitat for estuarine and anadromous fish, and supporting migration of adult and juvenile fish. Human activities such as reduced Delta inflow, exports from the Delta, and conversion of tidal wetlands have had a large influence on the natural hydraulic regime of the Bay-Delta. There are opportunities to restore or simulate, where and when appropriate, a more natural hydraulic regime that sustains ecological functions and meets the life requirements of the fish and wildlife in or dependent on the Bay-Delta.
Bay-Delta Aquatic Foodweb	The abundance of many species in the estuary may be limited by low productivity at the base of the food web in the estuarine ecosystem. The causes of this are complex and not well understood, but may include a shortage of productive shallow-water regions such as marshes, high turbidity in open-water regions of the estuary, and consumption and sequestering of available organic carbon by the Asiatic clam. Solving the problem directly is difficult but presumably other actions taken as part of the ERP, such as increasing the acreage of tidal or seasonally flooded marshlands, will contribute to the solution. A major obstacle to solving problems of estuarine productivity is our poor understanding so solutions will have to come from research and monitoring of effects of various ecosystem restoration projects.

Table 11. Distribution of Targets and Programmatic Actions for Ecological Processes by Ecological Management Zone.

[Note: Refer to Volume II: Ecological Management Zone Visions for more information regarding the specific targets and programmatic actions.]

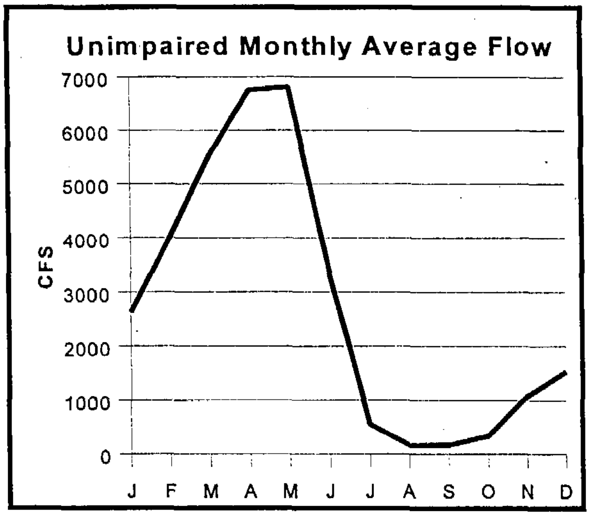
Ecological Process Vision	Ecological Management Zone[1]													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Central Valley Streamflows and Temperatures	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Coarse Sediment Supply	●	●	●	●	●	●	●	●	●	●	●	●	●	
Stream Meander			●	●	●		●	●	●			●	●	
Natural Floodplains and Flood Processes	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Bay-Delta Hydrodynamics	●	●												
Bay-Delta Aquatic Foodweb	●	●												

[1] *Ecological Management Zones*

1 = Sacramento-San Joaquin Delta
2 = Suisun Marsh/North San Francisco Bay
3 = Sacramento River
4 = North Sacramento Valley
5 = Cottonwood Creek
6 = Colusa Basin
7 = Butte Basin
8 = Feather River/Sutter Basin
9 = American River Basin
10 = Yolo Basin
11 = Eastside Delta Tributaries
12 = San Joaquin River
13 = East San Joaquin Basin
14 = West San Joaquin Basin

INTRODUCTION

Streamflow refers to the amount of fresh water flowing in rivers and Bay-Delta channels. Central Valley streamflows are a combination of natural discharges from surface water and groundwater and managed releases from reservoirs. Streamflow varies seasonally and annually with rainfall, run-off, and water-supply management. The volume and distribution of water in the Bay-Delta and its watersheds support important ecological processes and functions. Human activities have ~~had~~ a significant influence on the natural streamflow pattern of the Bay-Delta and its watershed.



Unimpaired Median Monthly Average Flow in the American River below Nimbus Dam, 1962-1992

RESOURCE DESCRIPTION

California is divided into hydrologic regions which reflect runoff and drainage basins. Three major hydrologic regions are contained within the ERPP Study Area: Sacramento River, San Joaquin River, and San Francisco Bay.

The Sacramento River Region contains the entire drainage of the Sacramento Valley and its adjacent watersheds and extends from Collinsville in the Sacramento-San Joaquin Delta almost 300 miles upstream to the Oregon border.

Characteristics of the Sacramento River Region

Average annual precipitation: 36 inches
Average annual runoff: 22,389,700 AF
Land area: 26,960 square miles
Population: 2,208,900

(Source: DWR 1994)

The San Joaquin River Region is located in the heart of California and is bordered by the Sierra Nevada on the east and the coastal range on the west.

Characteristics of the San Joaquin River Region

Average annual precipitation: 13 inches
Average annual runoff: 7,933,300 AF
Land area: 15,950 square miles
Population: 1,430,200

(Source: DWR 1994)

The San Francisco Bay Region extends from Pescadero Creek in southern San Mateo County to the mouth of Tomales Bay in the north and inland to the confluence of the Sacramento and San Joaquin rivers near Collinsville.

Characteristics of the San Francisco Bay Region

Average annual precipitation: 31 inches
Average annual runoff: 1,245,500 AF
Land area: 4,400 square miles
Population: 5,484,000

(Source: DWR 1994)

The total streamflow that would occur without upstream reservoirs and diversions is called the unimpaired flow. Data on unimpaired flows provide a record of natural streamflow patterns and a benchmark for judging the effects of water management and allocation of the available runoff. Unimpaired streamflows are also influenced by the condition of the upper watersheds and their ability to moderate or intensify runoff patterns.

Streamflows in Central Valley watersheds are extremely variable. Total annual unimpaired streamflow into and through the Central Valley varies from a low of about 5 million acre-feet (MAF) to a high of about 38 MAF. Most of the flow occurs December through June. A large part of the total flow volume occurs during relatively short periods of time, caused either by rainfall or snowmelt.

Construction and operation of dams on major rivers and streams has reduced peak winter and spring flows and increased summer and fall flows. Dry year flows are higher in some streams from release of carryover storage from reservoirs. In other streams, flow may be lower because of water diversions.

Winter and spring peak flows and summer and fall base flows are important to maintain ecological processes such as sediment transport, stream meandering, and riparian habitat regeneration. Native fish and wildlife species evolved with these flow patterns. Spawning and migrating fish depend on the natural streamflow patterns. For example, Sacramento splittail spawn during the late winter in flooded areas provided by high flows.

The ability to restore natural streamflows is limited. Constraints include water management practices, upper watershed conditions, and previous water supply allocation (water rights and contracts). Emulating natural runoff patterns will provide the greatest potential for improving the ecological functions that are dependent on streamflow.

ECOLOGICAL FUNCTIONS OF STREAMFLOW

Streamflow can be thought of as the life-blood of the tributary watersheds that link together to form the Sacramento and San Joaquin rivers. Groundwater and surface runoff generate flows into the stream networks in each tributary basin. Streamflow provides the geomorphic forces (energy and materials) needed to create and maintain stream channels and riparian corridors (floodplains). Streamflow controls the erosion, transport, and deposition of sediment in the stream channel and floodplain. Streamflow also transports and cleanses river gravels that support invertebrate production and fish spawning.

Natural flow patterns maintain natural sediment erosion, deposition, transport, and cleansing patterns, and thus natural stream channel and floodplain configurations. Reduced streamflow can lead to excessive sediment deposition in gravelbeds and armoring the channel with cobble.

Streamflows transport nutrients as well as dissolved and particulate organic material from rivers upstream to the Delta and estuary. These materials are important to planktonic and benthic foodweb organisms. Streamflows maintain soil moisture and transport seeds which contribute to the regeneration of riparian and riverine aquatic habitats.

Streamflow is needed to flood stream channel pools and riffles and riparian wetlands that provide habitat for fish and other wildlife. Flows transport fish eggs and larvae (e.g., striped bass, delta smelt) from spawning to nursery areas and may assist in the movement of juveniles from upstream spawning and rearing areas to the Delta (e.g., young splittail and chinook salmon).

Streamflow through the Delta to San Francisco Bay is referred to as Delta outflow. Delta outflow is simply the net flow at Chipps Island. Conceptually, it is estimated as the sum of Delta inflow and precipitation in the Delta minus water use in the Delta and exports from the Delta. Delta outflow has a major influence on the tidal mixing processes and the amount of saltwater that reaches upstream into the Delta. Delta outflow controls the location of the "zone of low salinity" (the area where freshwater mixes with saline water) and transports planktonic organisms, particulate organic materials, and nutrients from the rivers to the Delta and San Francisco Bay.

Following are general ecological processes and functions sustained with natural streamflow patterns:

- Channel-forming processes create and sustain the pools, riffles, meanders, sand and gravel deposits, banks, side channels, and floodplain areas. These elements are the physical framework for the stream, wetland, riparian corridor, and floodplain habitats.
- Streamflow transports nutrients and organic materials to downstream aquatic habitats where they provide the necessary components for primary (plant) and secondary (bacterial and

invertebrate) foodweb production. Transport processes also move larval and juvenile fish and other aquatic organisms to downstream rearing habitats.

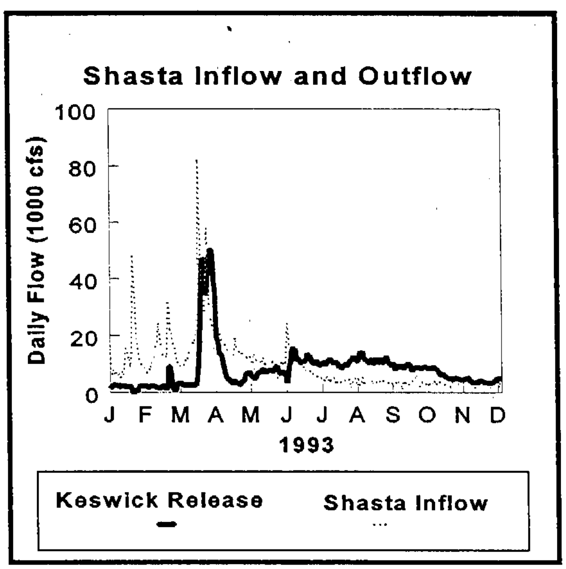
- Filling and flooding of channel and floodplain areas at high streamflows provide aquatic, wetland, and riparian habitat and sustain botanical processes (i.e., seed dispersal, soil moisture replenishment) within the floodplain, flood bypass, and riparian stream corridor.

HYDROLOGIC VARIATIONS

Water supplies in the Central Valley are categorized by "water-year classes" (wet, above normal, below normal, dry, and critical). This natural year-to-year hydrologic variability is used to establish water management plans. Facility operations are generally estimated using monthly rainfall and natural, unimpaired runoff conditions. Runoff is estimated from measured flows for 1922 to the present.

Seasonal variability results from rainfall events and snowmelt runoff. Rainfall events occur mainly during the "wet" season (between November and June). Substantial runoff from Sierra Nevada snowmelt extends into the summer and fall. This runoff pattern allows substantial diversion of water from Sacramento and San Joaquin river tributaries from May through September.

Central Valley reservoirs have been constructed during the last century to manage seasonal variability. Reservoirs capture winter floods and spring snowmelt (while reserving sufficient flood control storage space and maintaining minimum instream flows). This storage provides an increased water supply during summer and fall for diversions and instream flows.



MULTIPURPOSE WATER MANAGEMENT

Seasonal and annual runoff fluctuation complicates control and allocation of the available water supply. Water is allocated for various beneficial uses including flood control, water supply, power generation, and instream and other environmental flows. Priorities for streamflow management are established according to the available water supply.

Almost all major Central Valley streams are regulated by large multipurpose reservoirs (as well as smaller diversion dams) and confined by flood control levees. Many rules govern the operation of these dams and affect the overall operation of water-management systems. As the effects from these facilities on the natural runoff, sediment transport, riparian regeneration, and fish migration patterns are observed, an increased understanding of the needs for instream flows is emerging.

Recognition of the importance of streamflows to protect and promote habitat conditions for fish and wildlife populations has created conflicts between existing beneficial uses of water supply, industry, and flood control.

Several agencies may be involved in the operation of each major reservoir or diversion facility. The many rules governing facility operations have an incremental and interdependent effect on overall operation of water management systems.

WATER RIGHTS AND INSTREAM FLOW

California water rights govern streamflow allocation for beneficial uses. Both riparian and appropriative water rights exist in California. These rights are administered and monitored by the State Water Resources Control Board (SWRCB). Riparian rights support specific beneficial uses on lands immediately adjacent to the stream. Appropriative water rights allow direct diversion or storage and may be obtained for beneficial use.

Water rights are incremental, with a specific priority scheme that controls water allocation during periods of shortage. Federal courts have assigned the jurisdiction over several California streams that are used for single-purpose hydropower projects to the Federal Energy Regulatory Commission (FERC). Additional "exchange contracts" between water-rights holders and water districts or government agencies, such as the U.S. Bureau of Reclamation (Reclamation) or California Department of Water Resources (DWR) further complicate the allocation of California water supplies.

Instream flow levels are sometimes required as conditions for water quality standards, water-rights permits, and FERC licenses. Negotiated agreements between water and fisheries agencies govern minimum flows downstream of major water projects. Some streams or stream segments, such as a portion of Butte Creek, are formally managed by State watermaster agreements.

The SWRCB has included instream spring flow requirements for both Delta outflow (i.e., X2 location objectives) and the San Joaquin River at Vernalis in the 1995 Water Quality Control Plan. Instream flow requirements govern the minimum flows at specific points below diversions and are often dependent on the available water supply (e.g., water-year type). Average annual instream and spring flow requirements are generally a small fraction of natural unimpaired flow and winter releases from storage reservoirs may be much less than unimpaired flows.

Many streams have no instream flow requirements. On some streams, riparian and appropriative water rights diversions may be restricted only by an amount necessary to supply downstream users having a higher priority water right. Some Central Valley streamflows are totally depleted downstream of the major diversions during the irrigation season.

ISSUES AND OPPORTUNITIES

NATURAL FLOW REGIMES. Native habitats and species in the Bay-Delta ecosystem evolved in the context of a highly variable flow regime punctuated by extreme seasonal and inter-annual changes in flow. The construction of dams and the diversion of water from Bay-Delta tributaries and the Delta have reduced the variability of the flow regime, especially by reducing peak flows and altering Bay-Delta hydrodynamics. The decrease in the variability of the flow regime is one factor that may be contributing to the explosion of exotic and invasive species, so it is hypothesized that restoring variable flows will help create habitat conditions that favor native species. However, a completely natural flow regime for a river reach below a dam is not possible (because of human water demand) and may not even be desirable since the pre-dam sediment supply has been cut off. The desired conditions below every major dam are likely to be different, suggesting a need for experimental manipulations of flows, including moderate annual floodflows, and habitat to find the right combination of factors that will maximize ecosystem benefits or assist endangered species in ways that are compatible with other uses of water and river corridors (Strategic Plan 2000).

OPPORTUNITIES: Mimic natural flow regimes through innovative methods to manage reservoir releases. There is underutilized potential to modify reservoir operations rules to create more dynamic, natural high-flow regimes in regulated rivers without seriously impinging on the water storage purposes for which the reservoir was constructed. Water release operating rules could be changed to ensure greater variability of flow, provide adequate spring flows for riparian vegetation establishment, simulate effects of natural floods in scouring riverbeds and creating point bars, and increase the frequency and duration of overflow onto adjacent floodplains. In some cases, downstream infrastructure of river floodways may require upgrading to accommodate safely a more desirable natural variability and peak discharge magnitude associated with moderate floodflows (e.g., strengthen or set levees back) (Strategic Plan 2000).

VISION

The vision for Central Valley streamflows is to protect and enhance the ecological functions that are achieved through the physical and biological processes that operate within the stream channel and associated riparian and floodplain areas in order to assist in the recovery of at-risk species, biotic communities, and overall health of the Bay-Delta.

To achieve maximum potential ecological functions and benefits from streamflows will require restoring and protecting the stream channel and floodplain process and in developing and implementing watershed management strategies and programs to protect the health of upper watersheds.

Opportunities to protect, enhance, and restore natural streamflow patterns and processes depend on stream channel and floodplain conditions, as well as existing impoundments and diversions.

Opportunities for adjusting seasonal streamflow patterns to benefit fish and wildlife while maintaining other beneficial water uses will be explored. Opportunities may include acquiring water rights from willing sellers or developing supplemental supplies (e.g., recycled water programs). Individual water rights are established according to California law, and this vision does not propose any adjudication or involuntary reallocation of water rights.

Many environmental factors and functions controlled by streamflow dynamics are only partially understood at this time. Therefore, the vision for Central Valley streamflow includes a substantial commitment to continued monitoring and evaluation of physical, chemical, and biological processes and ecological functions that are sustained and governed by streamflow.

Although the historical pattern of natural streamflows can be used as a guideline for establishing streamflow targets, the actual management of flows for each tributary or river segment will require coordination with all agencies and stakeholders. Conflicting interests and priorities will most likely be the rule rather than the exception. Streamflow targets will be developed within the existing multipurpose water resource management framework for each watershed.

INTEGRATION WITH OTHER RESTORATION PROGRAMS

The vision for streamflow is intended to complement existing streamflow management programs. Several agencies are directly or indirectly responsible for streamflow management.

Agencies with important streamflow management responsibilities and programs include:

- U.S. Army Corps of Engineers' flood control operations of reservoirs and management of flood control facilities (e.g., levees, overflow channels and bypass weirs);
- DWR programs to provide water supplies (State Water Project), flood protection facilities, water quality monitoring, and multipurpose management of California water resources;
- Reclamation's operation of the Central Valley Project (and several other independent water projects in the Central Valley) to provide for multiple beneficial water uses, including fish and wildlife protection and habitat restoration (e.g., Central Valley Project Improvement Act);
- FERC regulation of minimum flows below hydropower projects;
- SWRCB administration of water rights for storage and diversions, including decisions about required instream flows for fish, water quality, and public trust resource protection;
- California Department of Fish and Game responsibility to study and recommend streamflows and temperature requirements for fish protection and propagation in streams and at hatcheries;
- U.S. Fish and Wildlife Service and National Marine Fisheries Service programs to recommend flows and other measures needed for mitigating impacts from federal projects and protecting endangered species, including the Anadromous Fish Restoration Program and the Water Management Program; and
- U.S. Geological Survey water resources division programs to measure streamflow and water quality, providing the information necessary for adaptive management of streamflows. Their monitoring and modeling activities for Central Valley groundwater and Bay-Delta hydrodynamics are also important contributions to water resources management.

Streamflows in Central Valley streams are being addressed under the Central Valley Improvement Act (CVPIA) subsection 3406(b)(2) and (b)(3) programs being administered by the USFWS. Under 3406(b)(2) 800 TAF of CVP water is to be allocated for fish and wildlife purposes. Under 3406(b)(3) additional water is to be acquired from willing sellers.

The combined sources of water are to be managed under a Water Management Plan being developed for selected individual rivers under FERC licensing requirements, negotiated settlements between stakeholders and agencies, State Water Resources Control Board water rights and water quality plans, and court ordered settlements such as that for the American River (Water Forum).

LINKAGE TO MULTI-SPECIES CONSERVATION STRATEGY

The interdependence of stream hydrology, fluvial geomorphology, and riparian habitats is of great relevance to the protection, restoration, maintenance, and recovery of MSCS evaluated species. Virtually all aquatic species, many riparian species, and some terrestrial species are dependent on habitats created, formed, or maintained by streamflow for nursery, forage, resting, or reproductive areas.

The basis of the ERP, and the key to the recovery of MSCS evaluated species, is the restoration of natural ecological processes. In highly altered or developed hydrologic units, understanding the role of altered streamflow patterns on existing habitats and species is critical to developing viable and effective restoration measures.

After decades of cumulative impacts, the majority of Central Valley rivers have been transformed from dynamic alluvial systems capable of forming their own stream beds and bank configurations to fossilized systems confined between berms, dikes, and levees or fossilized as a result of vegetation that has encroached into the low flow channel. The loss of coarse sediments captured behind the large dams has reduced or eliminated an essential ecological ingredient required for the creation of alternate bar features and in-stream and floodplain habitat structure. This, when combined with the significant reduction in natural stream flow patterns, especially high flows, has prevented regenerative fluvial processes from promoting river recovery. Not only are the components necessary for healthy river ecosystems no longer available (sediment supplies), the natural processes are impaired or lacking (high flow regimes).

LINKAGE WITH OTHER ECOSYSTEM ELEMENTS

Streamflow is a primary ecosystem process and is integrally linked with other processes, habitats, and species. In addition, the effects of many ecological stressors are influenced by streamflow.

In all cases, the ecological value of streamflows will be incorporated into a comprehensive adaptive management program. (The Strategic Plan for Ecosystem Restoration, 2000, contains additional information regarding CALFED's approach to adaptive management.) This program for Central Valley streamflows will necessarily focus on the relationship of flow to the health of closely related ecological processes, habitats, and species.

Processes influenced by streamflow include:

- Central Valley water temperatures,
- coarse sediment supply,
- stream meander corridors,
- Bay-Delta aquatic foodweb,
- floodplain and flood processes,
- groundwater/surface water interactions, and
- dilution of contaminants.

Habitats that depend on streamflow include:

- riparian,
- aquatic, and
- wetlands.

Species directly linked to streamflow include:

- anadromous fish,
- delta smelt,
- resident fish,
- riparian dependent species,
- riparian plant communities
- shorebirds, and
- waterfowl.

Each of these processes, habitats, and species is adversely affected by stressors which restrict their full function, extent, distribution, or survival. Therefore, the full ecological benefit to be derived from streamflows also depends on reduction or elimination of stressors which impair other closely related ecosystem elements. Streamflow is an important ingredient for ecological health, but cannot provide full benefit without improvement in other areas.

OBJECTIVES, TARGETS, ACTIONS, AND MEASURES

Streamflows are addressed by two strategic objectives.

> One Strategic Objective for streamflow is to establish hydrologic regimes in streams, including sufficient flow timing, magnitude, duration, and high flow frequency, to maintain channel and sediment conditions supporting the recovery and restoration of native aquatic and riparian species and biotic communities.

LONG-TERM OBJECTIVE: For regulated rivers in the region, establish scientifically based high-flow events necessary to maintain dynamic channel processes, channel complexity, bed sediment quality, and natural riparian habitats where feasible.

SHORT-TERM OBJECTIVE: Through management of the reservoir pool or deliberate reservoir releases, provide a series of experimental high-flow events in regulated rivers to observe flow effects on bed mobility, bed sediment quality, channel migration, invertebrate assemblages, fish abundance, and riparian habitats over a period of years. Use the findings of these studies to reestablish natural stream processes where feasible, including restoration of periodic inundation of remaining undeveloped floodplains.

RATIONALE: Native aquatic and riparian organisms in the Central Valley evolved under a flow regime with pronounced seasonal and year-to-year variability. Frequent (annual or longer term) high flows mobilized gravel beds, drove channel migration, inundated floodplains, maintained sediment quality for native fishes and invertebrates, and maintained complex channel and floodplain habitats. By deliberately releasing such flows from reservoirs, at least some of these physical and ecological functions can probably be recreated. A program of such high-flow releases, in conjunction with natural high-flow events, lends itself well to adaptive management because the flows can easily be adjusted to the level needed to achieve specific objectives. However, it should be recognized that channel adjustments may lag behind hydrologic changes by years or decades, requiring long-term monitoring. Also, on most rivers, reservoirs are not large enough to eliminate extremely large, infrequent events so these will continue to affect channel form at irregular, often long, intervals; artificial high-flow events may be needed to maintain desirable channel configurations created during the natural events. This objective focuses on flows that are likely to be higher than those needed to maintain most native fish species but that are important for maintaining in-channel and riparian habitats for fish as well as other species (e.g., invertebrates, birds, mammals). Experimental flow releases also will have to be carefully monitored for negative effects, such as encouraging the invasion of unwanted non-native species.

STAGE 1 EXPECTATIONS: Studies should be conducted on five to 10 regulated rivers in the Central Valley to determine the effects of high-flow releases. Natural floodplains should be identified that can be inundated with minimal disruption of human activity. Where positive benefits are shown, flow recommendations should be developed and instituted where feasible.

> A second Strategic Objective for streamflow is to create and/or maintain flow and temperature regimes in rivers that support the recovery and restoration of native aquatic species.

LONG-TERM OBJECTIVE: Native fish and invertebrate assemblages will be restored to regulated streams where feasible, using methods developed during the short-term objective phase.

SHORT-TERM OBJECTIVE: Provide adequate flows, temperatures, and other conditions to double the number of miles (as of 1998) of regulated streams that are dominated (>75% by numbers and biomass) by assemblages with four or more native fish species.

RATIONALE: Virtually all streams in the region are regulated to some degree, and the regulated flow regimes frequently favor non-native fishes. The native fish assemblages (including those with anadromous fishes) are increasingly uncommon. Recent studies in Putah Creek, the Stanislaus River, and the Tuolumne

River demonstrate that native fish assemblages can be restored to sections of streams if flow (and temperature) regimes are manipulated in ways that favor their spawning and survival, usually by having flow regimes that mimic natural patterns in winter and spring but that increase flows during summer and fall months (to make up for loss of upstream summer habitats). Native invertebrates and riparian plants may also respond positively to these flow regimes. Achievement of this objective will require additional systematic manipulations of flows below dams (or the re-regulation of existing flow regimes) to determine the optimal flow and habitat conditions for native organisms, as part of the short-term goal. Part of the studies should be to determine if the objective can be achieved without "new" water, by just altering the timing of releases or by developing conjunctive use agreements that allow more water to flow down the stream channel. Ways to restore native fish communities that do not involve changed flows should be developed (where feasible) to be used in place of or synergistically with changed flows. These findings can then be applied opportunistically to achieve the long-term goal of restoring native fish communities.

STAGE 1 EXPECTATIONS: Surveys will have been completed to determine the status of native fishes in all regulated streams of the Central Valley and flow recommendations made to restore native fishes where feasible. During negotiations for relicensing of dams, agency personnel should evaluate and consider flow regimes favorable for native fishes.

RESTORATION ACTIONS

The general target for streams with large water storage reservoirs is to provide a spring flow event that emulates natural spring pulse flows in dry and normal years. For all streams provide sufficient year-round base flows to sustain important ecological processes, habitats, and species.

Actions that will contribute to restoring the ecological values of stream flow include maintaining spring flows and sustaining summer-fall base flows are the two major streamflow restoration activities considered in this vision. The following three programmatic actions will help to achieve streamflow objectives:

- Provide sufficient high flows during spring (March-May) to sustain high-flow dependent ecological functions. This can be accomplished by allowing a portion of the natural inflow to pass through large Central Valley reservoirs in spring of all but the driest years. In extreme cases, this may be accompanied by reductions in high summer storage releases.
- Maintain sufficient year round base flows to sustain aquatic streamflow dependent ecological processes, habitat, and species.
- Provide sufficient flow during the first yearly significant rain event to sustain habitat and species dependent on such flow. This can be accomplished by allowing a portion of the natural inflow to pass through large Central Valley reservoirs in all but the driest years.

MSCS CONSERVATION MEASURES

The following conservation measures were included in the Multi-Species Conservation Strategy (2000) to provide additional detail to ERP actions that would help achieve species habitat or population targets. Although the measures focus on at-risk species, some have direct connections to the manner in which streamflows in the Central Valley influence species or their habitats.

- Improve January and February flows for the longfin smelt during the second and subsequent years of drought periods.
- Consistent with CALFED objectives, mobilize organic carbon in the Yolo Bypass to improve food supplies by ensuring flow through the bypass at least every other year.
- Provide sufficient Delta outflows for the longfin smelt from December through March.
- For green sturgeon, provide inflows to the Delta from the Sacramento River greater than 25,000 cfs during the March to May spawning period in at least 2 of every 5 years.
- To the extent consistent with CALFED objectives, manage export flows from the San Joaquin River to improve conditions for